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May 15, 1997

Attorney Docket No.: **AM2001(204001)**

**BOX PATENT APPLICATION**

Assistant Commissioner of Patents  
Washington, DC 20231

Presented for filing is a new original patent application of:

**Applicant:** TOM OSTERHELD AND SEN-HOU KO  
**Title :** POLISHING PAD HAVING A GROOVED PATTERN FOR  
USE IN A CHEMICAL MECHANICAL POLISHING  
SYSTEM

Enclosed are the following papers, including all those required for a filing date  
under 37 CFR §1.53(b):

Pages of Specification	13
Pages of Claims	2
Pages of Abstract	1
Signed Declaration	[To Be Filed At A Later Date]
Sheets of Drawing	5

Basic filing fee	770.00
Total claims in excess of 20 times \$22.00	0.00
Independent claims in excess of 3 times \$80.00	80.00
Multiple dependent claims	0.00
Total filing fee:	\$ 850.00

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Chris J. Keyser  
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May 15, 1997

Page 2

A check for the filing fee is enclosed. Please charge any other required fees, or apply any credits, to Deposit Account No. 06-1050, referencing the Attorney Docket number shown above.

Please direct all future correspondence as follows:

Patent Counsel  
Legal Affairs Department  
Applied Materials, Inc.  
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If this application is found to be INCOMPLETE, or if it appears that a telephone conference would helpfully advance prosecution, please telephone the undersigned at 415/322-5070.

Kindly acknowledge receipt of this application by returning the enclosed postcards.

Respectfully submitted,



David J. Goren  
Reg. No. 34,609

Enclosures  
68651.P11

68651.P11

**APPLICATION**  
**FOR**  
**UNITED STATES LETTERS PATENT**

**TITLE:** POLISHING PAD HAVING A GROOVED PATTERN FOR USE  
IN A CHEMICAL MECHANICAL POLISHING SYSTEM

**APPLICANT:** TOM OSTERHELD AND SEN-HOU KO

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Chris J. Keyser  
Chris J. Keyser

POLISHING PAD HAVING A GROOVED PATTERN FOR  
USE IN A CHEMICAL MECHANICAL POLISHING SYSTEM

5                   Background of the Invention

The present invention relates generally to chemical mechanical polishing of substrates, and more particularly to a polishing pad having a grooved pattern for a chemical mechanical polishing system.

10                  Integrated circuits are typically formed on substrates, particularly silicon wafers, by the sequential deposition of conductive, semiconductive or insulative layers. After each layer is deposited, the layer is etched to create circuitry features. As a series of layers are  
15 sequentially deposited and etched, the outer or uppermost surface of the substrate, i.e., the exposed surface of the substrate, becomes increasingly non-planar. This non-planar outer surface presents a problem for the integrated circuit manufacturer. If the outer surface of the substrate is non-  
20 planar, then a photoresist layer placed thereon is also non-planar. A photoresist layer is typically patterned by a photolithographic apparatus that focuses a light image onto the photoresist. If the outer surface of the substrate is sufficiently non-planar, the maximum height difference  
25 between the peaks and valleys of the outer surface may exceed the depth of focus of the imaging apparatus. Then it will be impossible to properly focus the light image onto the entire outer surface. Therefore, there is a need to periodically planarize the substrate surface to provide a  
30 flat surface for photolithography.

Chemical mechanical polishing (CMP) is one accepted method of planarization. This method typically requires

that the substrate be mounted on a carrier or polishing head. The exposed surface of the substrate is then placed against a rotating polishing pad. The carrier head provides a controllable load, i.e., pressure, on the substrate to  
5 push it against the polishing pad. In addition, the carrier head may rotate to provide additional motion between the substrate and polishing surface.

A polishing slurry, including an abrasive and at least one chemically-reactive agent, may be supplied to the  
10 polishing pad to provide an abrasive chemical solution at the interface between the pad and the substrate. CMP is a fairly complex process, and it differs from simple wet sanding. In a CMP process, the reactive agent in the slurry reacts with the outer surface of the substrate to form  
15 reactive sites. The interaction of the polishing pad and abrasive particles with the reactive sites on the substrate results in polishing.

An effective CMP process has a high polishing rate and generates a substrate surface which is finished (lacks  
20 small-scale roughness) and flat (lacks large-scale topography). The polishing rate, finish and flatness are determined by the pad and slurry combination, the relative speed between the substrate and pad, and the force pressing the substrate against the pad. The polishing rate sets the  
25 time needed to polish a layer. Because inadequate flatness and finish can create defective substrates, the selection of a polishing pad and slurry combination is usually dictated by the required finish and flatness. Given these constraints, the polishing time needed to achieve the  
30 required finish and flatness sets the maximum throughput of the CMP apparatus.

One problem in CMP relates to slurry distribution. As was indicated above, the CMP process is fairly complex, requiring the interaction of the polishing pad, abrasive particles and reactive agent with the substrate to obtain

5 the desired polishing results. Accordingly, ineffective distribution of the slurry across the surface of the polishing pad provide less than optimal polishing results. Polishing pads have been used which include perforations about the pad. The perforations, when filled, distribute  
10 slurry in their respective local region as the polishing pad is compressed. This method of slurry distribution has limited effectiveness because each perforation in effect acts independently. Thus, some of the perforations may have too little slurry, while others may have too much slurry.  
15 Furthermore, there is no way to directly channel the excess slurry to where it is needed.

Another problem in CMP is "glazing" of the polishing pad. Glazing occurs when the polishing pad is heated and compressed in regions where the substrate is pressed against  
20 it. The peaks of the polishing pad are pressed down and the pits of the polishing pad are filled up, so the surface of the polishing pad becomes smoother and less abrasive. As a result, the polishing time required to polish a substrate increases. Therefore, the polishing pad surface must be  
25 periodically returned to an abrasive condition, or "conditioned", to maintain a high throughput.

In addition, during the conditioning process, waste materials associated with abrading the surface of the pad may fill or clog the perforations in the polishing pad.  
30 Filled or clogged perforations can not hold slurry, thereby reducing the effectiveness of the polishing process.

An additional problem associated with filled or

clogged perforations relates to the separation of the polishing pad from the substrate after polishing has been completed. The polishing process produces a high degree of surface tension between the polishing pad and the substrate.

5 The perforations decrease the surface tension by reducing the contact area between the polishing pad and the substrate. However, as the perforations become filled or clogged with waste material, the surface tension increases, making it more difficult to separate the polishing pad and  
10 the substrate. As such, the substrate is more likely to be damaged during the separation process.

Yet another problem in CMP is referred to as the "planarizing effect". Ideally, a polishing pad only polishes peaks in the topography of the substrate. After a  
15 predefined period of polishing, the areas of these peaks will eventually be level with the valleys, resulting in a planar surface. However, if a substrate is subjected to the "planarizing effect", the peaks and valleys will be polished simultaneously. The "planarizing effect" results from the  
20 compressible nature of the polishing pad in response to point loading. In particular, if the polishing pad is too flexible, it will deform and contact a large surface area of the substrate.

Accordingly, it would be useful to provide a CMP  
25 system which reduces or solves some, if not all, of these problems.

#### Summary of the Invention

In one aspect, the present invention is directed to a polishing pad for polishing a substrate in a chemical  
30 mechanical polishing system. The polishing pad has a polishing surface having a plurality of substantially

circular grooves. The grooves having a depth of at least about 0.02 inches, a width of at least about 0.015 inches, and a pitch of at least about 0.09 inches.

Implementations of the invention include the following. The grooves may be concentrically arranged and uniformly spaced over the polishing surface. The grooves may have a depth between 0.02 and 0.05 inches, such as 0.03 inches, a width between about 0.015 and 0.04 inches, such as 0.02 inches, and a pitch between about 0.09 and 0.24 inches, such as 0.12 inches. The polishing pad may comprise an upper layer and a lower layer with the grooves being formed in the upper layer. The upper layer may have a thickness between about 0.06 and 0.12 inches, and the distance between a bottom portion of the grooves and the lower layer may be about 0.04 inches.

In another aspect, a polishing surface of the polishing pad has a spiral groove having a depth of at least about 0.02 inches, a width of at least about 0.015 inches, and a pitch of at least about 0.09 inches.

In another aspect, a polishing surface of the polishing pad has a plurality of grooves separated by partitions, the grooves having a depth of at least about 0.02 inches and a width of at least about 0.015 inches and the partitions having a width of at least about 0.075 inches. The ratio of the width of the grooves to the partitions is between about 0.10 and 0.25.

Advantages of the invention include the following. The grooves of the polishing pad provide an effective way to distribute slurry across the pad. The grooves are sufficiently wide that waste material produced by the conditioning process can be flushed from the grooves. The polishing pad is sufficiently rigid to avoid the



"planarizing effect". The polishing pad's relatively deep grooves also improve the pad lifetime.

Other features and advantages will be apparent from the following description, including the drawings and  
5 claims.

#### Brief Description of the Drawings

FIG. 1 is a schematic exploded perspective view of a chemical mechanical polishing apparatus.

FIG. 2 is a schematic cross-sectional view of a  
10 carrier head and a polishing pad.

FIG. 3 is a schematic top view of a polishing pad according to the present invention.

FIG. 4 is a schematic cross-sectional view of the polishing pad of FIG. 3 along line 4-4.

15 FIG. 5 is a schematic top view of a polishing pad using a spiral groove.

#### Detailed Description of the Preferred Embodiment(s)

Referring to FIG. 1, one or more substrates 10 will be polished by a chemical mechanical polishing apparatus 20.  
20 A complete description of polishing apparatus 20 may be found in U.S. Patent Application Serial No. 08/549,336, entitled RADIALLY OSCILLATING CAROUSEL PROCESSING SYSTEM FOR CHEMICAL MECHANICAL POLISHING, filed October 27, 1995 by Ilya Perlov, et al., and assigned to the assignee of the  
25 present invention, the entire disclosure of which is incorporated herein by reference. According to the present invention, polishing apparatus 20 includes a lower machine base 22 with a table top 23 mounted thereon and a removable outer cover (not shown). Table top 23 supports a series of  
30 polishing stations 25a, 25b and 25c, and a transfer station

27. Transfer station 27 forms a generally square arrangement with the three polishing stations 25a, 25b and 25c. Transfer station 27 serves multiple functions, including receiving individual substrates 10 from a loading apparatus (not shown), washing the substrates, loading the substrates into carrier heads (to be described below), receiving the substrates from the carrier heads, washing the substrates again, and finally, transferring the substrates back to the loading apparatus.

Each polishing station includes a rotatable platen 30 on which is placed a polishing pad 32. If substrate 10 is an eight inch (200 millimeter) diameter disk, then platen 30 and polishing pad 32 will be about twenty inches in diameter. Platen 30 may be a rotatable aluminum or stainless steel plate connected to a platen drive motor (not shown). For most polishing processes, the platen drive motor rotates platen 30 at thirty to two hundred revolutions per minute, although lower or higher rotational speeds may be used.

Each polishing station 25a-25c may further include an associated pad conditioner apparatus 40. Each pad conditioner apparatus 40 has a rotatable arm 42 holding an independently-rotating conditioner head 44 and an associated washing basin 46. The conditioner apparatus maintains the condition of the polishing pad so it will effectively polish any substrate pressed against it while it is rotating.

A slurry 50 containing a reactive agent (e.g., deionized water for oxide polishing), abrasive particles (e.g., silicon dioxide for oxide polishing) and a chemically-reactive catalyzer (e.g., potassium hydroxide for oxide polishing) is supplied to the surface of polishing pad 32 by a combined slurry/rinse arm 52. The slurry/rinse arm

may include two or more slurry supply tubes to provide  
slurry to the surface of the polishing pad. Sufficient  
slurry is provided to cover and wet the entire polishing pad  
32. Slurry/rinse arm 52 also includes several spray nozzles  
5 (not shown) which provide a high-pressure rinse of polishing  
pad 32 at the end of each polishing and conditioning cycle.

Two or more intermediate washing stations 55a and  
55b may be positioned between neighboring polishing stations  
25a, 25b and 25c. The washing stations rinse the substrates  
10 as they pass from one polishing station to another.

A rotatable multi-head carousel 60 is positioned  
above lower machine base 22. Carousel 60 is supported by a  
center post 62 and is rotated thereon about a carousel axis  
64 by a carousel motor assembly located within base 22.  
15 Center post 62 supports a carousel support plate 66 and a  
cover 68. Carousel 60 includes four carrier head systems  
70a, 70b, 70c, and 70d. Three of the carrier head systems  
receive and hold substrates, and polish them by pressing  
them against polishing pads 32 on platens 30 of polishing  
20 stations 25a-25c. One of the carrier head systems receives  
a substrate from and delivers a substrate to transfer  
station 27.

The four carrier head systems 70a-70d are mounted on  
carousel support plate 66 at equal angular intervals about  
25 carousel axis 64. Center post 62 allows the carousel motor  
to rotate carousel support plate 66 and to orbit carrier  
head systems 70a-70d and the substrates attached thereto  
about carousel axis 64.

Each carrier head system 70a-70d includes a carrier  
30 or carrier head 80. Each carrier head 80 independently  
rotates about its own axis. A carrier drive shaft 74  
connects a carrier head rotation motor 76 (shown by the

removal of one quarter of cover 68) to carrier head 80. There is one carrier drive shaft and motor for each head. In addition, each carrier head 80 independently laterally oscillates in a radial slot 72 formed in carousel support plate 66. A slider (not shown) supports each drive shaft 74 in radial slot 72. A radial drive motor (not shown) may move the slider to laterally oscillate the carrier head.

The carrier head 80 performs several mechanical functions. Generally, the carrier head holds the substrate against the polishing pad, evenly distributes a downward pressure across the back surface of the substrate, transfers torque from the drive shaft to the substrate, and ensures that the substrate does not slip out from beneath the carrier head during polishing operations.

Referring to FIG. 2, each carrier head 80 includes a housing assembly 82, a base assembly 84 and a retaining ring assembly 86. A loading mechanism may connect base assembly 84 to housing assembly 82. The base assembly 84 may include a flexible membrane 88 which provides a substrate receiving surface for the carrier head. A description of carrier head 80 may be found in U.S. Patent Application Serial No. 08/745,679, entitled A CARRIER HEAD WITH A FLEXIBLE MEMBRANE FOR A CHEMICAL MECHANICAL POLISHING SYSTEM, filed November 8, 1996, by Steven M. Zuniga et al., assigned to the assignee of the present invention, the entire disclosure of which is incorporated herein by reference.

As shown in FIGS. 2-4, polishing pad 32 may comprise a hard composite material having a roughened polishing surface 34. Polishing pad 32 may have an upper layer 36 and a lower layer 38. Lower layer 38 may be attached to platen 30 by a pressure-sensitive adhesive layer 39. Upper layer 36 may be harder than lower layer 38. Upper layer 36 may be

composed of polyurethane or polyurethane mixed with a filler. Lower layer 38 may be composed of compressed felt fibers leached with urethane. A two-layer polishing pad, with the upper layer composed of IC-1000 and the lower layer composed of SUBA-4, is available from Rodel, Inc., of Newark, Delaware (IC-1000 and SUBA-4 are product names of Rodel, Inc.).

Referring to FIGS. 3 and 4, a plurality of concentric circular grooves 100 are disposed in polishing surface 34 of polishing pad 32. Advantageously, these grooves are uniformly spaced with a pitch P. The pitch P is the radial distance between adjacent grooves. Between each groove is an annular partition 110 having a width  $W_p$ . Each groove 100 includes walls 104 which terminate in a substantially U-shaped base portion 106. Each groove may have a depth  $D_g$  and a width  $W_g$ .

The walls 104 may be generally perpendicular and terminate at U-shaped base 106. Each polishing cycle results in wear of polishing pad 32, generally in the form of thinning of the polishing pad as polishing surface 34 is worn down. The width  $W_g$  of a groove with substantially perpendicular walls 104 does not change as the polishing pad is worn. Thus, the generally perpendicular walls ensure that the polishing pad has a substantially uniform surface area over its operating lifetime.

The polishing pad of the present invention include wide and deep grooves in comparison to those used in the past. The grooves 100 have a minimum width  $W_g$  of about 0.015 inches. Each groove 100 may have a width  $W_g$  between about 0.015 and 0.04 inches. Specifically, the grooves may have a width  $W_g$  of approximately 0.020 inches. Each partition 110 may have a width  $W_p$  between about 0.075 and

0.20 inches. Specifically, the partitions may have a width  $W_p$  of approximately 0.10 inches. Accordingly, the pitch  $P$  between the grooves may be between about 0.09 and 0.24 inches. Specifically, the pitch may be approximately 0.12 inches.

The ratio of groove width  $W_g$  to partition width  $W_p$  may be selected to be between about 0.10 and 0.25. The ratio may be approximately 0.2. If the grooves are too wide, the polishing pad will be too flexible, and the "planarizing effect" will occur. On the other hand, if the grooves are too narrow, it becomes difficult to remove waste material from the grooves. Similarly, if the pitch is too small, the grooves will be too close together and the polishing pad will be too flexible. On the other hand, if the pitch is too large, slurry will not be evenly transported to the entire surface of the substrate.

The grooves 100 also have a depth  $D_g$  of at least about 0.02 inches. The depth  $D_g$  may be between about 0.02 and 0.05 inches. Specifically, the depth  $D_g$  of the grooves may be approximately 0.03 inches. Upper layer 36 may have a thickness  $T$  between about 0.06 and 0.12 inches. As such, the thickness  $T$  may be about 0.07 inches. The thickness  $T$  should be selected so that the distance  $D_p$  between the bottom of base portion 106 and lower layer 38 is between about 0.035 and 0.085 inches. Specifically, the distance  $D_p$  may be about 0.04 inches. If the distance  $D_p$  is too small, the polishing pad will be too flexible. On the other hand, if the distance  $D_p$  is too large, the polishing pad will be thick and, consequently, more expensive.

Referring to FIG. 3, grooves 100 form a pattern defining a plurality of annular islands or projections. The surface area presented by these islands for polishing is

between about 10% and 25% of the total surface area of polishing pad 32. As a result, the surface tension between the substrate and the polishing pad is reduced, facilitating separation of the polishing pad from the substrate at the completion of a polishing cycle.

Referring to FIG. 5, in another embodiment, a spiral groove 120 is disposed in polishing surface 34' of polishing pad 32'. Advantageously, the groove is uniformly spaced with a pitch P. A spiral partition 130 separates the rings of the spiral. Spiral groove 120 and spiral partition 130 may have the same dimensions as circular groove 100 and circular partition 110. That is, spiral groove 120 may have depth of at least about 0.02 inches, a width of at least about 0.015 inches, and a pitch of at least about 0.09 inches. Specifically, spiral groove 120 may have a depth between 0.02 and 0.05 inches, such as 0.03 inches, a width between about 0.015 and 0.40 inches, such as 0.20 inches, and a pitch P between about 0.09 and 0.24 inches, such as 0.12 inches.

The grooves provide air channels which reduce any vacuum build-up between the polishing pad and the substrate. However, as the surface area available for polishing decreases, an accompanying increase in the polishing time may be required to achieve the same polishing results.

The grooves may be formed in polishing surface 34 by cutting or milling. Specifically, a saw blade on a mill may be used to cut grooves in polishing surface 34. Alternatively, grooves may be formed by embossing or pressing polishing surface 34 with a hydraulic or pneumatic press. The relatively simple groove pattern avoids expensive machining.

As was described above, slurry/rinse arm 52 provides

slurry 50 to polishing surface 34. The continuous channels about the polishing pad provided by the grooves facilitate the migration of slurry 50 around the polishing pad. Thus, excess slurry 50 in any region of polishing pad 32 may be transferred to another region by the groove structure, providing more uniform coverage of slurry 50 over polishing surface 34. Accordingly, slurry distribution performance is improved and any variations in the polishing rate attributable to poor slurry distribution will be reduced.

In addition, the grooves reduce the possibility that waste materials generated during the polishing and conditioning cycles may become trapped and interfere with slurry distribution. The grooves facilitate the migration of waste materials away from the polishing pad surface (i.e., uppermost surface of partitions 110 or 130), reducing the possibility of clogging. The grooves will collect waste during the polishing and conditioning processes, reducing the amount of waste which will remain on the polishing pad surface. The width of the grooves permits a spray rinse from slurry/rinse arm 52 to effectively flush the waste materials from the grooves.

The depth of the grooves improves polishing pad lifetime. As discussed above, the conditioning process abrades and removes material from the surface of the polishing pad, thereby reducing the depth of the grooves. Consequently, the lifetime of the pad may be increased by increasing the depth of the grooves.

The invention is not limited to the embodiment depicted and described. Rather, the scope of the invention is defined by the appended claims.

What is claimed is:



1           1.    A polishing pad for polishing a substrate in a  
2 chemical mechanical polishing system, comprising:  
3           a polishing surface having a plurality of  
4 substantially circular grooves, the grooves having a depth  
5 of at least about 0.02 inches, a width of at least about  
6 0.015 inches, and a pitch of at least about 0.09 inches.

1           2.    The polishing pad of claim 1 wherein the  
2 grooves are concentrically arranged.

1           3.    The polishing pad of claim 1 wherein the  
2 grooves are uniformly spaced over the polishing surface.

1           4.    The polishing pad of claim 1 wherein the  
2 grooves have a depth between about 0.02 and 0.05 inches.

1           5.    The polishing pad of claim 4 wherein the  
2 grooves have a depth of approximately 0.03 inches.

1           6.    The polishing pad of claim 1 wherein the  
2 grooves have a width between about 0.015 and 0.04 inches.

1           7.    The polishing pad of claim 6 wherein the  
2 grooves have a width of approximately 0.02 inches.

1           8.    The polishing pad of claim 1 wherein the  
2 grooves have a pitch between about 0.09 and 0.24 inches.

1           9.    The polishing pad of claim 8 wherein the  
2 grooves have a pitch of approximately 0.12 inches.

1           10.   The polishing pad of claim 1 wherein the

1 polishing pad further comprises an upper layer and a lower  
2 layer, the grooves being formed in the upper layer.

1 11. The polishing pad of claim 10 wherein the upper  
2 layer has a thickness between about 0.06 and 0.12 inches.

1 12. The polishing pad of claim 11 wherein the  
2 distance between a bottom portion of the grooves and the  
3 lower layer is about 0.04 inches.

1 13. A polishing pad for polishing a substrate in a  
2 chemical mechanical polishing system, comprising:  
3 a polishing surface having a plurality of  
4 substantially circular grooves, the grooves having a depth  
5 of approximately 0.03 inches, a width of approximately 0.02  
6 inches, and a pitch of approximately 0.12 inches.

1 14. A polishing pad for polishing a substrate in a  
2 chemical mechanical polishing system, comprising:  
3 a polishing surface having a spiral groove having a  
4 depth of at least about 0.02 inches, a width of at least  
5 about 0.015 inches, and a pitch of at least about 0.09  
6 inches.

1 15. A polishing pad for polishing a substrate in a  
2 chemical mechanical polishing system, comprising:  
3 a polishing surface having a plurality of grooves  
4 separated by partitions, the grooves having a depth of at  
5 least about 0.02 inches and a width of at least about 0.015  
6 inches and the partitions having a width of at least about  
7 0.075 inches, wherein the ratio of the width of the grooves  
8 to the partitions is between about 0.10 and 0.25.

## Abstract of the Disclosure

66928.P11

**COMBINED DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that:

This declaration is of the following type:

- ☒ original  
☐ divisional  
☐ continuation  
☐ continuation-in-part

**INVENTORSHIP IDENTIFICATION**

My residence, post office address and citizenship are as stated below next to my name. I believe I am the original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**TITLE OF INVENTION**

*POLISHING PAD HAVING A GROOVED PATTERN FOR USE IN A  
CHEMICAL MECHANICAL POLISHING SYSTEM*

**SPECIFICATION IDENTIFICATION**

The specification of which:

- ☐ is attached hereto  
☒ was filed on **May 15, 1997**  
☐ under Serial No. \_\_\_\_\_ ; or  
☐ with Express Mail No. \_\_\_\_\_ (as Serial No. not yet known)  
and was amended on \_\_\_\_\_ (if applicable)  
☐ was described and claimed in PCT International Application No. \_\_\_\_\_  
filed on \_\_\_\_\_ and as amended under PCT Article 19 on \_\_\_\_\_.

**ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose all information I know to be material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56,

and which is material to the examination of this application; namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and

- ☐ In compliance with this duty there is attached an Information Disclosure Statement in accordance with 37 CFR §1.98.

**PRIORITY CLAIM (35 U.S.C. §119)**

I hereby claim foreign priority benefits under Title 35, United States Code, §119, of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below, and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

☒ No such applications have been filed.

☐ Such applications have been filed as follows:

- A. Prior foreign/PCT application(s) filed within 12 mos. (6 mos. for design) prior to this application, and any priority claims under 35 U.S.C. §119

<u>Country/PCT</u>	<u>Application No</u>	<u>Date Filed</u>	<u>Priority Claimed</u>
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

- B. All foreign application(s), if any, filed more than 12 mos. (6 mos for design) prior to this U.S. application

Country:  
Application No:  
Filing date:

Table 1. Demographic and Clinical Characteristics of the Study Population	
Characteristic	Value
Number of patients	100
Male/Female	55/45
Age (mean $\pm$ SD)	65.2 $\pm$ 12.5
Duration of disease (mean $\pm$ SD)	12.3 $\pm$ 8.7
Site of origin	
Colon	45
Rectum	55
Stage at diagnosis	
I	15
II	35
III	40
IV	10
Histological type	
Adenocarcinoma	90
Mucinous	10
Undifferentiated	0
Metastatic sites	
Liver	40
Lung	30
Bone	20
Soft tissue	10

☒ No such applications have been filed.  
☐ Such applications have been filed as follows:

## POWER OF ATTORNEY

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## DECLARATION

*I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and, further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Sec. 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.*

Full name of **first** inventor: Tom Osterheld

Inventor's signature: \_\_\_\_\_ Date: \_\_\_\_\_

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Full name of **second** inventor: Sen-hou Ko

Inventor's signature: \_\_\_\_\_ Date: \_\_\_\_\_

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**FIG.**  
**1**

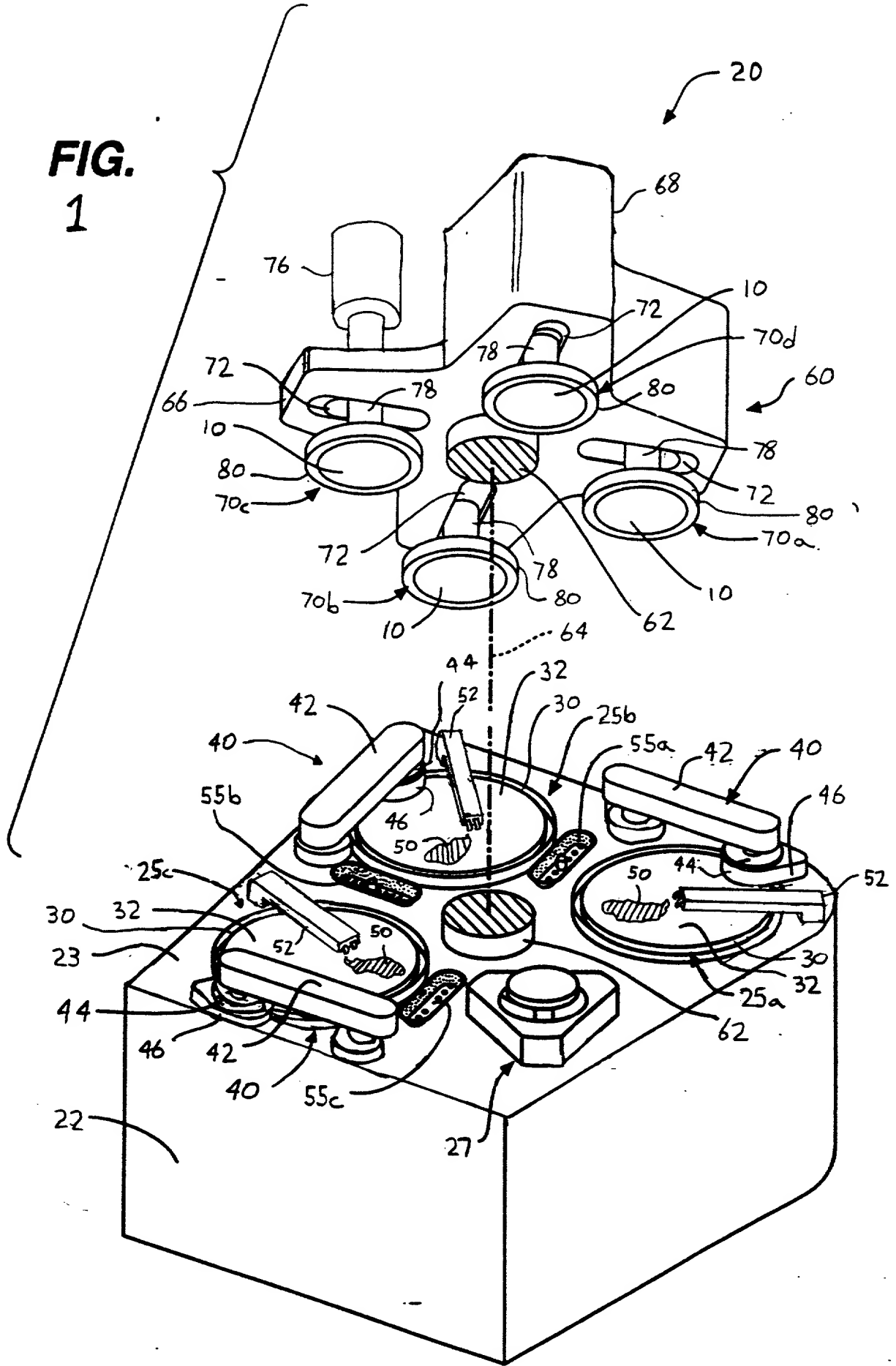
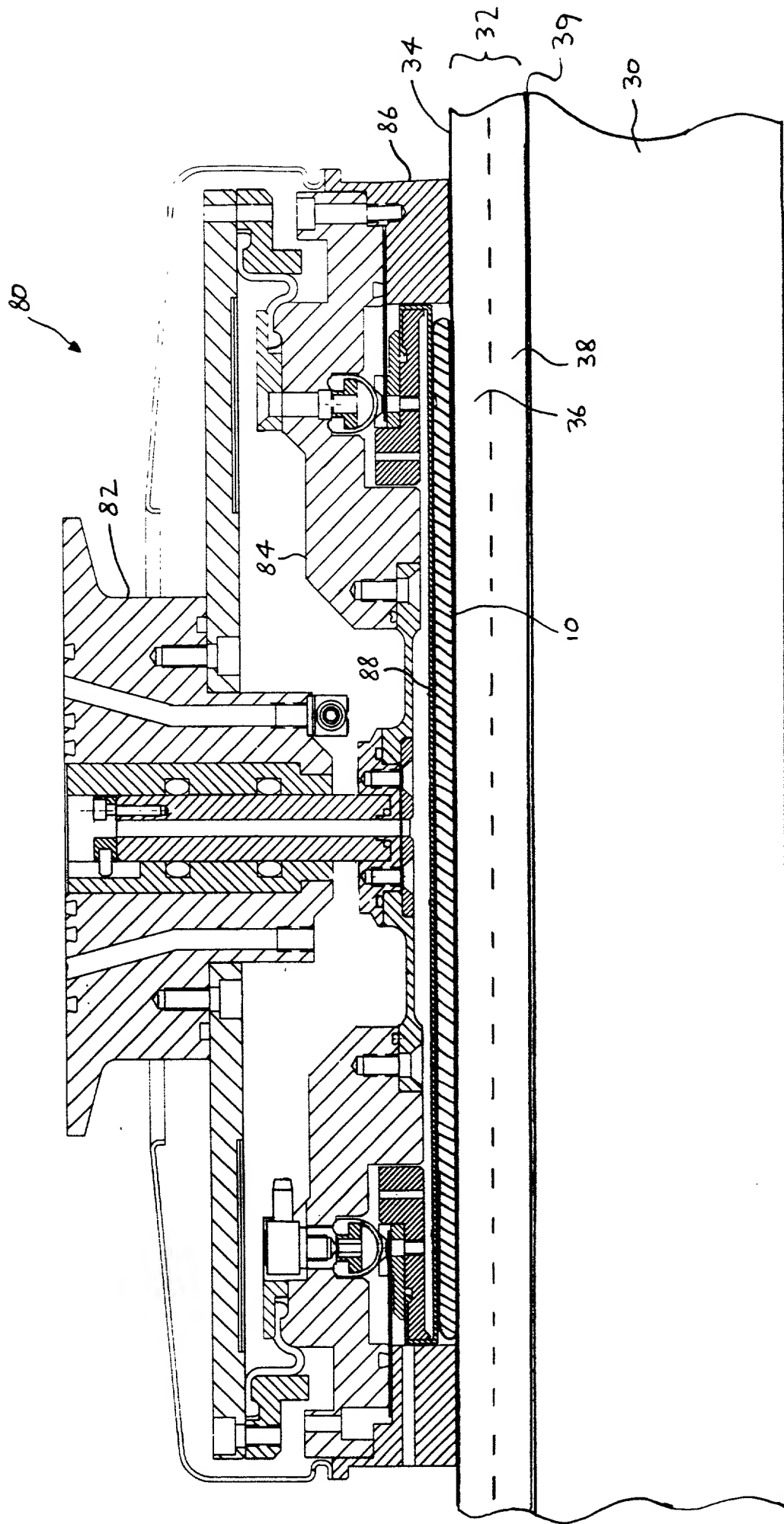




FIG. 2



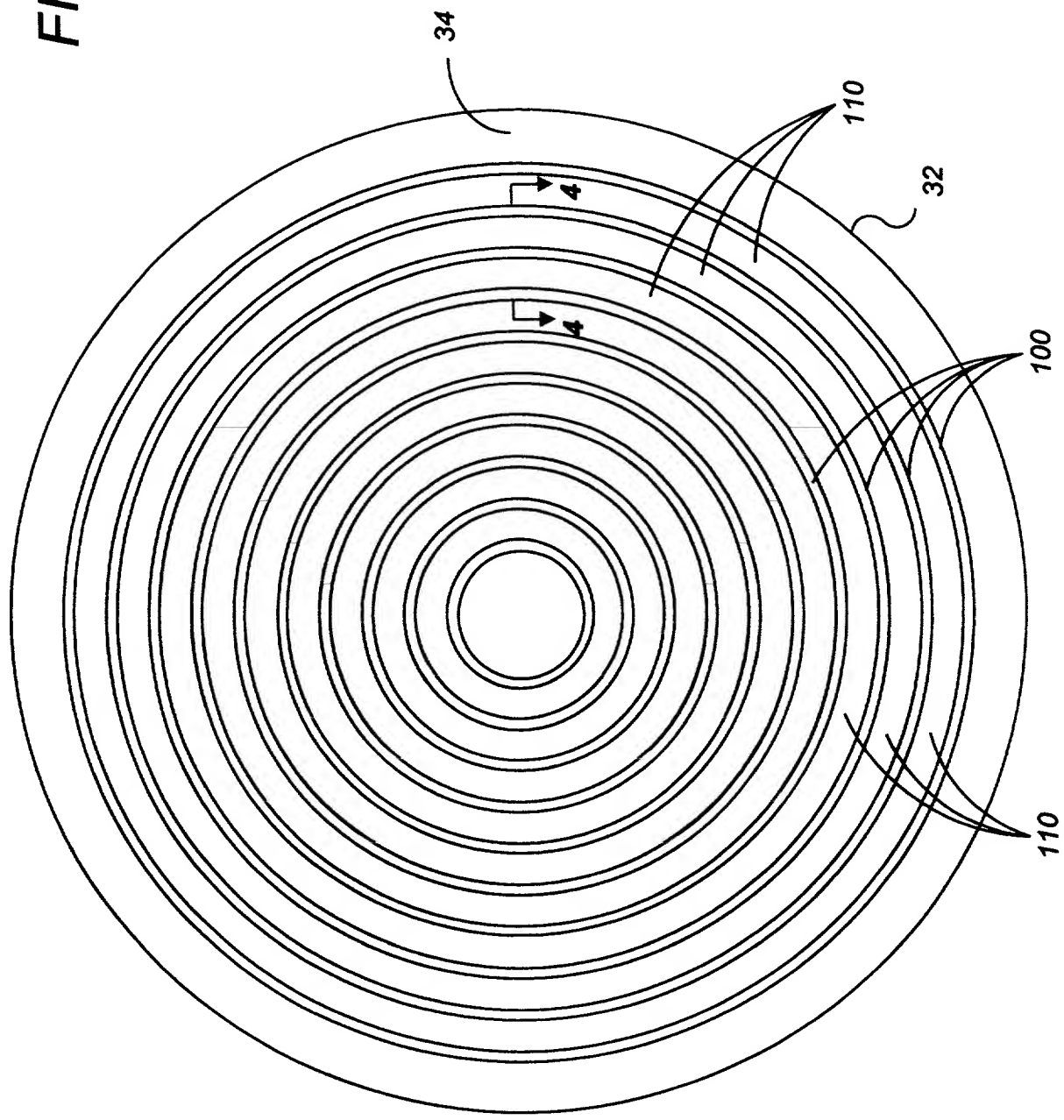
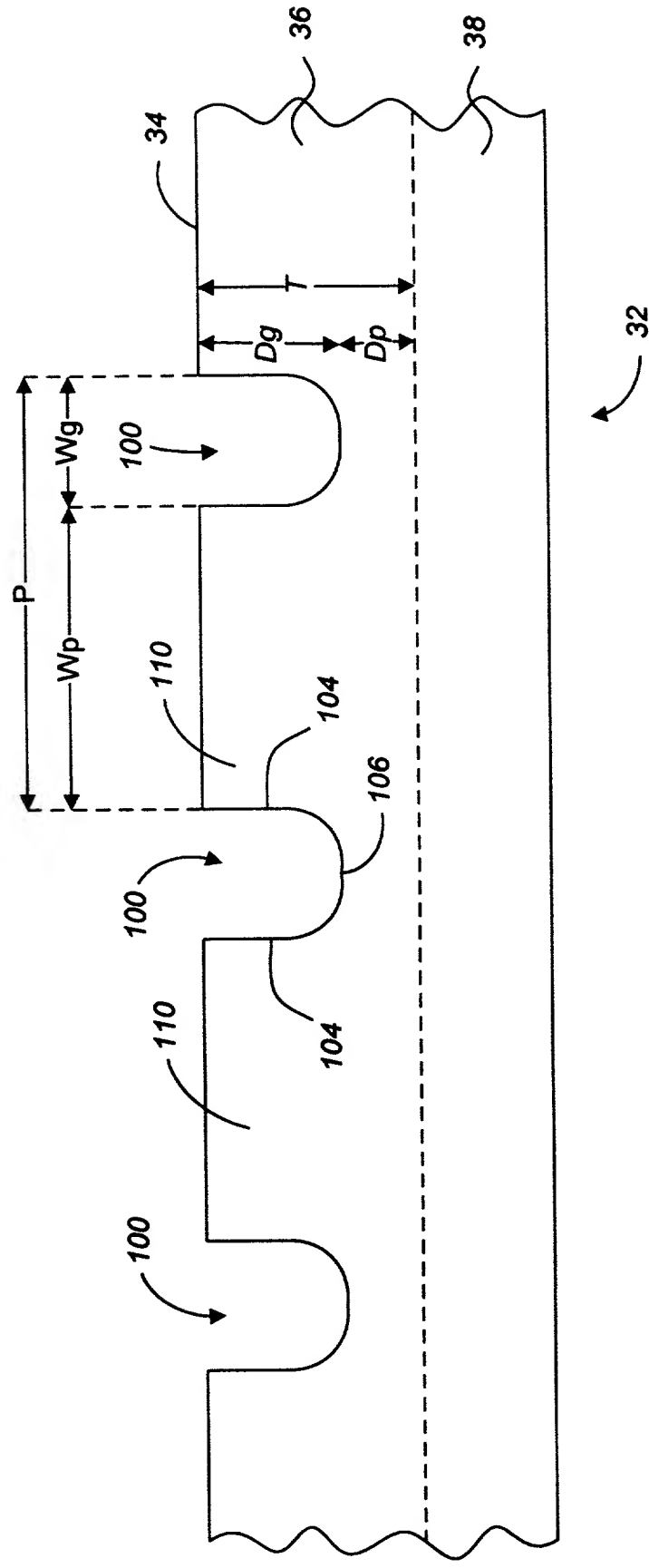


FIG. 3



**FIG. 4**

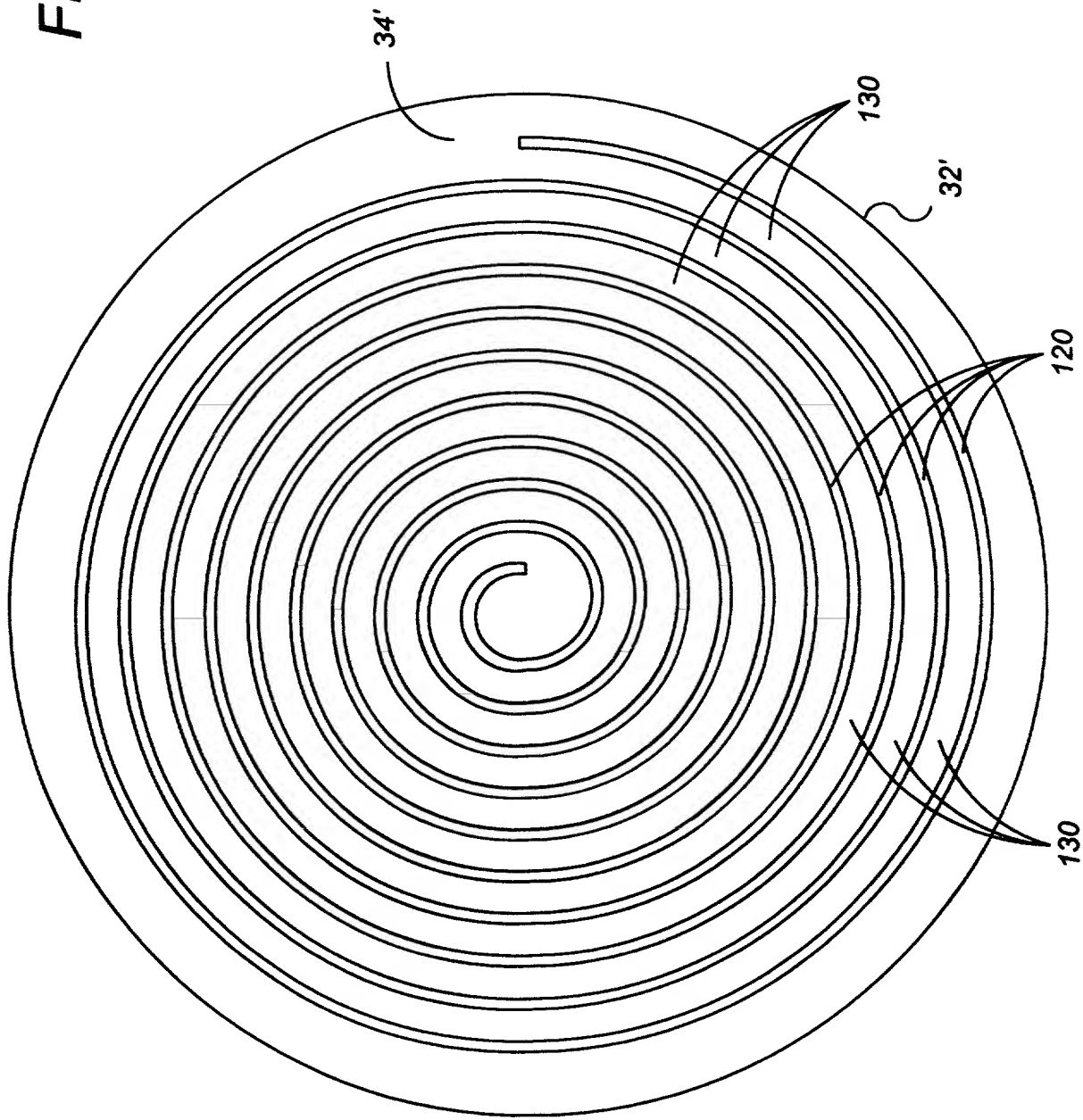


FIG. 5